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FERTILIZERS

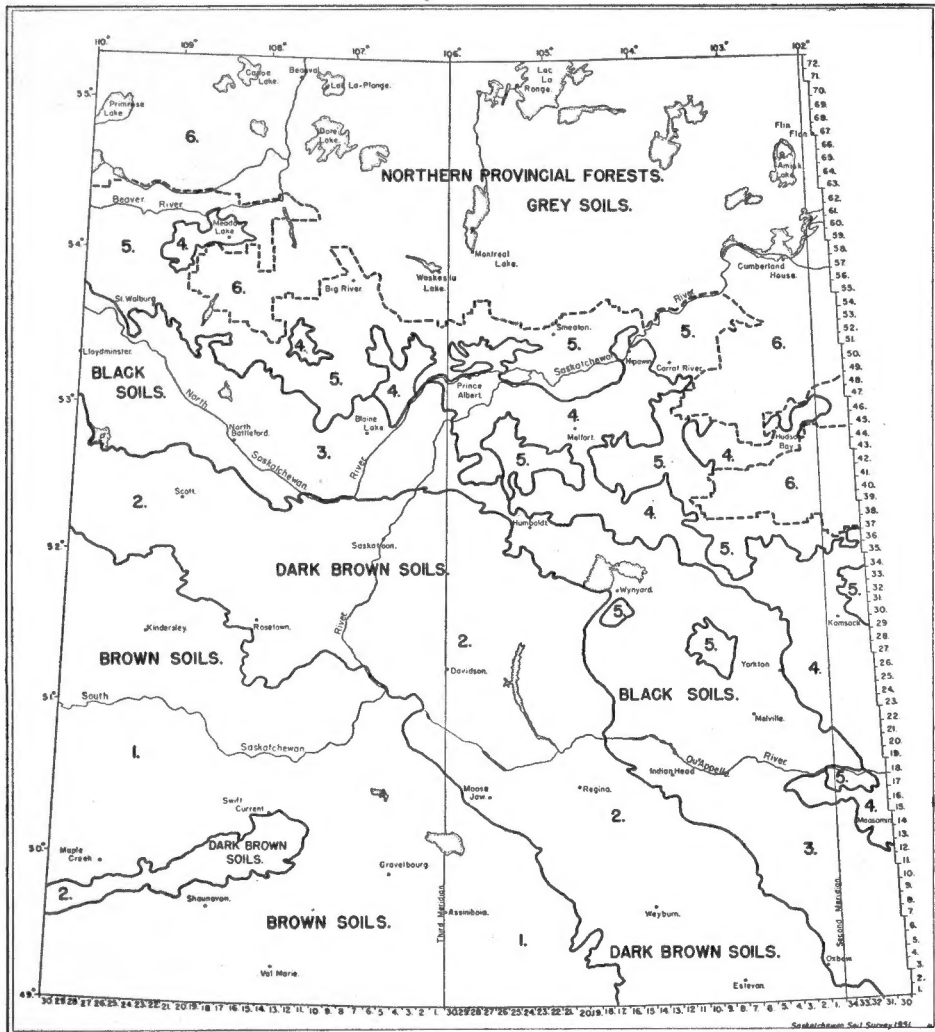
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DEPARTMENT OF SOILS

SASKATOON • SASKATCHEWAN

The Soil Zones of Saskatchewan



LEGEND

1. Brown Soils of the open prairie, the most arid section of the province. Wide variations in crop yields and frequent severe droughts.
2. Dark Brown Soils of the prairie, less arid than the Brown Soils. Variable crop yields but less frequent severe droughts.
3. Black Soils of the parkland. Better moisture conditions and better average yields than on the prairie. Severe droughts rarely experienced.
4. Thick Black and Slightly Degraded Soils of the parkland-forest belt. Good moisture conditions and high crop yields.
5. Grey Wooded and Strongly Degraded Soils of the forest region. Moisture conditions good, but soils are low in organic matter and general fertility.
6. Grey Soils and Muskeg of the unsettled Northern Provincial Forest.

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FERTILIZERS IN SASKATCHEWAN

By H. G. DION and J. MITCHELL

1.—WHAT IS A FERTILIZER?

A fertilizer is any material added to a soil to improve the supply of some nutrient or nutrients. Farm manure is a fertilizer which has been in use for centuries. Commercial fertilizers (sometimes called chemical fertilizers) have been in use for over one hundred years. Fertilizers may supply any of the twelve nutrient elements plants obtain from the soil and which are needed for their growth. Generally fertilizers supply one or more of the elements nitrogen, phosphorus or potassium. If a fertilizer supplies all three of the elements, nitrogen, phosphorus and potassium, it is called a complete fertilizer.

If an animal is lacking a mineral (for example, calcium) or a vitamin, we feed the animal something containing the mineral or vitamin to enable it to have better health and to make better growth. If a soil lacks adequate amounts of some element which plants need as a nutrient we add fertilizer to the soil and so improve the plant's health, growth, and yield.

2.—WHY ARE FERTILIZERS NEEDED?

Growing plants absorb from the soil phosphorus, nitrogen, potassium, sulphur, calcium, magnesium, iron, manganese, copper, zinc and boron. These are essential for the full development of the plant. While many other elements such as chlorine and aluminum may be absorbed by the plants, the list given above is usually considered to include the necessary plant nutrients or "plant foods."

If the supply of one or more of these nutrient elements is insufficient in the soil, the growth of the crop will suffer, and yields will be reduced. The lack of a nutrient element is corrected by the use of a fertilizer containing that element.

The nutrient elements most likely to be lacking in Saskatchewan soils are phosphorus, sulphur and nitrogen. In other parts of the world, calcium and potassium are of great importance, but our soils have plentiful supplies of these, except perhaps on some of the deep peats and very sandy soils of Northern Saskatchewan.

3.—WHAT DO THE NUMBERS ON A FERTILIZER BAG MEAN AND WHAT IS A FERTILIZER ANALYSIS?

The numbers on the fertilizer bag represent the analysis of the fertilizer, and give the percentage of nitrogen (N), phosphate (P_2O_5) and potash (K_2O). The fertilizer laws of Canada require that every fertilizer container show the analysis of the fertilizer it contains, to protect the purchaser, and give him the information he needs.

Some typical analyses are shown below:

11 48-0		
11% nitrogen	48% phosphate	0% potash
2-16-6		
2% nitrogen	16% phosphate	6% potash
21-0-0		
21% nitrogen	0% phosphate	0% potash
16 20-0		
16% nitrogen	20% phosphate	0% potash

The part of the fertilizer not identified in the analysis consists of calcium, oxygen and a number of other constituents which may be combined with the fertilizer elements, or may be present as a result of the manufacturing process. The content of other elements important in plant nutrition, such as sulphur (for legumes on the grey wooded soils)

may be indicated on the bag, although they are not expressed in the nitrogen-phosphate-potash formula.

4.—DOES CROPPING INCREASE THE NEED FOR FERTILIZERS?

Yes. Every bushel of wheat, pound of butter or beef, or gallon of milk sold off the farm means a certain amount of phosphorus, nitrogen, potassium and other mineral elements taken from the soil. Ultimately this must be replaced if production at a high level is to be maintained. 15 bushels of wheat contain more phosphorus than 15 pounds of 11-48-0 Ammonium Phosphate, our best fertilizer, so that it is easy to see that fertility levels can only be maintained by the proper application of fertilizer.

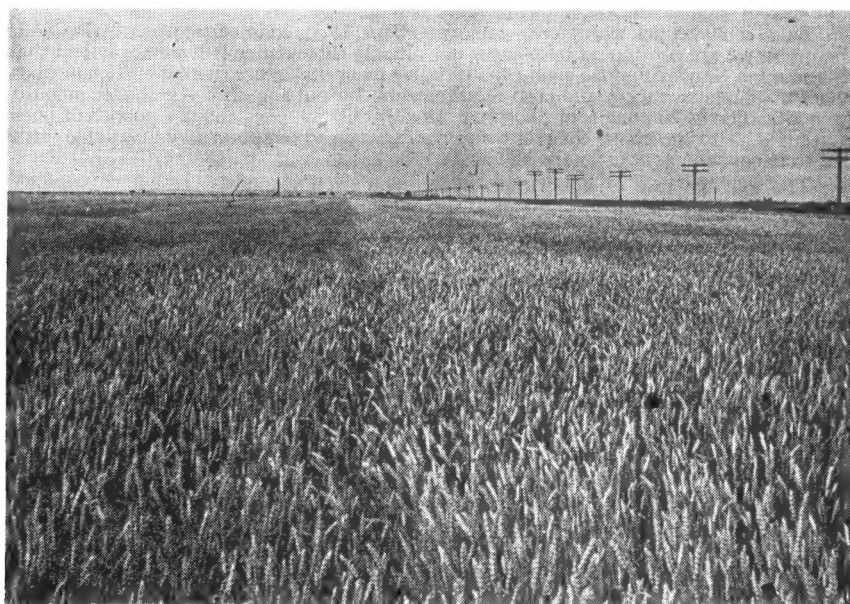
The phosphorus supplies in our soils were never high, even under virgin conditions. Native grass often contains insufficient phosphate to feed grazing animals adequately, and in these cases, must be supplemented with bone meal, or some other suitable phosphate carrier. Fifty years of cropping to cereals has reduced the amount of available phosphate in our soils markedly, and the return to high levels of production is made by the application of phosphate fertilizer.

The following table gives the amounts of the three most important plant nutrients required to grow good yields of our common crops, and the amount of these nutrients we lose from the land by harvesting the grain, assuming the straw is returned to the soil.

TABLE 1.—The Amount of Fertilizer Elements Contained in Field Crops

Crop and Yield	Lbs. required to grow a crop			Lbs. removed in grain		
	Nitrogen	Phosphate	Potash	Nitrogen	Phosphate	Potash
Wheat—30 bus.....	51.5	20.6	28.9	35.5	14.9	9.0
Oats —30 bus.....	50.0	19.5	51.9	35.0	13.8	9.0
Barley—40 bus.....	47.0	20.6	38.0	35.0	16.0	10.2
Flax —15 bus.....	51.0	16.0	27.1	30.5	12.6	7.8
Alfalfa—3 tons.....	143.0	32.7	135.0	—	—	—

We can easily calculate that thirty crops of wheat at an average yield of 15 bushels have removed more than 220 pounds of phosphate (P_2O_5) per acre.



Unfertilized

Fertilized
11-48-0 at about 40 pounds

Note earliness and uniformity of ripening in fertilized crop. More heads and better filled heads are often noticeable in fertilized crops.

5.—DO WE NEED FERTILIZERS IN SASKATCHEWAN?

Yes, definitely. About 70% of summerfallow crops in Saskatchewan would give increases in yield with fertilizer, these increases averaging from 5 to 7 bushels per acre, using the proper amount of fertilizer. In addition, a large proportion of the stubble crops in the Black, Degraded Black, and Grey Wooded Soil Zones will also respond well to fertilizer.

6.—WHAT KIND OF FERTILIZER IS NEEDED FOR SASKATCHEWAN SOILS?

Naturally, the kind of fertilizer needed is going to be determined by the particular requirements of crops and soils. Potash fertilizers are not necessary in Saskatchewan (unless we have greater development of agriculture on our deeper peats and light sandy soils of the north). Nitrogen is generally adequate on summerfallow crops, but may be short in stubble crops of the more humid parts of the province. Phosphates do not give profitable increases on the lighter textured Brown Soils.

Most of the particular requirements are mentioned below:

Summerfallow crops: Phosphate the main requirement—use a highly available phosphate fertilizer such as 11-48-0 ammonium phosphate.

Stubble crops: Phosphate and nitrogen. Available nitrogen supplies are liable to be short because of cropping the previous year. In addition, a temporary shortage of nitrogen may result from working in a lot of stubble too deeply.

Alfalfa for seed production: Sulphur and phosphate. Sulphur in the grey soils is not present in sufficient quantities for legumes, which require large amounts.

Grass fields for hay and pasture: Phosphate at the time of seeding and nitrogen broadcast later to correct the "sod-bound" condition.

Grey-Wooded Soils: Nitrogen and phosphate for cereals. Nitrogen supplies are short because of the low organic matter content.

7.—HOW MUCH FERTILIZER IS NEEDED FOR SUMMERFALLOW CROPS IN SASKATCHEWAN?

About 20 pounds of phosphate (P_2O_5) per acre are required for summerfallow crops where fertilizer is recommended. This represents about 40 pounds of our usual fertilizer, ammonium Phosphate 11-48-0.

Since a 30-bushel wheat crop removes about 15 pounds of phosphate (P_2O_5) in the grain, we are continuing to exhaust our already deficient soils if we apply less than this amount. Similarly, if we want big yields, we must make sure there is sufficient phosphate available to supply the crop requirements, by putting on a reasonable amount. An application of 20 pounds of phosphate (P_2O_5) only supplies about 7 pounds of phosphate (P_2O_5) to the plant; the rest being transformed to temporarily unavailable forms due to chemical reactions in the soil.

The average rate of application of Ammonium Phosphate 11-48-0 to summerfallow crops is still too low, although it has increased greatly over the average rate of about 20 pounds per acre used some years ago. Tests on 184 farms for the period 1939-50 covering most areas of Saskatchewan give the increases listed below:

TABLE II—Average Yield Increases on Summerfallow Wheat—1939-50

Soil Zone	No. of Tests	Average increase from 11-48-0 in bushels per acre	
		20 lbs./acre	40 lbs./acre
Dark Brown	71	4.0	5.5
Black	83	5.2	7.2
Degraded Black and Grey.....	30	4.0	6.2
Average.....	184	4.5	6.4

The results over this 12-year period under average farm conditions indicate quite definitely that the 40-pound rate of 11-48-0 Ammonium Phosphate is much more profitable than the 20-pound rate. From 1.5 to 2.2 bushels extra are given by the extra 20 pounds of 11-48-0, at a cost of 93-96 cents for the extra fertilizer.

On the heavy soils particularly, (Sceptre Clay, Elstow Clay, Regina Heavy Clay, Indian Head Clay, Melfort and Tisdale Silty Clay Loam), the light rates of phosphate application (18-25 pounds of 11-48-0 per acre) seem relatively ineffective, while the heavier rates around 40-50 pounds usually give increases greater than the 5.5-7.2 bushels indicated above.

8.—DO HEAVY RATES OF FERTILIZER APPLICATION CAUSE BURNING IN MID-SEASON?

No, in general. In the tests carried out by the Soils Department under average farming conditions in Saskatchewan rates of application of up to 80 pounds per acre of 11-48-0 and 96 pounds per acre of 16-20-0 are commonly used. In general the highest rates give the highest yields, although the greatest profit is made at about 40-60 pounds per acre of 11-48-0 on the average. The data below illustrate this fact.

TABLE III—Average of 34 Tests (1947-50) on Black and Degraded Black Soils

	Rate of Application of 11-48-0 lbs./acre			
	20	40	60	80
Average Yield Increase—bus./acre	2.8	4.3	5.5	5.4
Profit per acre Wheat at \$1.50, Fertilizer at \$95.00/Ton	3.25	4.55	5.40	4.30

Phosphate fertilizers are sometimes accused of "burning" the crop when mid-summer droughts occur. In most cases this effect is due to normal ripening, which may occur up to 10-15 days earlier in the fertilized crop. Very occasionally we may find that this extra earliness is not beneficial—particularly in years when late-sown crops yield better, but this is uncommon.

9.—IS FERTILIZER OF ANY VALUE UNDER DRY CONDITIONS?

For summerfallow crops with a good subsoil moisture reserve, phosphates often give their biggest increases under relatively dry conditions, probably because the fertilized crop is able to take up subsoil moisture reserves more efficiently. Under dry conditions with poor moisture reserves the increases are smaller, but usually still profitable.

Recently evidence has been obtained indicating that even under drought conditions the fertilizer phosphate is still available. At Birsay in 1950, with a yield of only 2 to 4 bushels of wheat per acre, it was established that 70 to 80% of the phosphorus in the plant came from the fertilizer applied, and only 20 to 30% from the soil. In this case, even when the moisture supply was so limited as to prevent reasonable growth, the availability of the Ammonium Phosphate was still high.

Dry years in general give smaller yield increases from phosphate than reasonably moist years.

TABLE IV—Moisture Supply and Fertilizer Response
Average of 15 tests in each year on summerfallow wheat (Saskatoon-Humboldt area)

Rate of Application of 11-48-0	Increase in bushels per acre		
	1941—dry year	1942—moist year	average 1939-43
25 lbs./acre	2.8	11.3	7.9
50 lbs./acre	4.5	13.4	10.2

10.—IS FERTILIZER EFFECTIVE ON LIGHT SOILS?

Tests on light textured sandy soils have indicated good responses to phosphate except in the Brown Soil Zone, where these soils are in general unsuited to cultivated crops. Since light soils are more subject to drought, the conditions mentioned above with respect to dry conditions apply in general. In the Park Belt (Black and Degraded Black soils) and in the Grey-Wooded regions, the sandy soils will not produce well without adequate supplies of phosphate (and nitrogen, usually).

11.—IS FERTILIZER EFFECTIVE ON STUBBLE CROPS?

In the Black and Degraded Black soils of the Park Belt and the Grey-Wooded Soils of the Forested Region of Saskatchewan, good indications of responses to phosphate and to phosphate and nitrogen have been obtained. There is not sufficient experimental work as yet to make a definite recommendation, but on the basis of a few trials, it can be said that stubble crops will give a profitable response in a great many cases, as illustrated below:

TABLE V—Stubble Yield Increases

	Yield Increase from		
	11-48-0	16-20-0	
	40 lbs.	48 lbs.	96 lbs.
1949 Crozier, Indian Head (Wheat).....	5.8	2.3	9.6
1949 Geall, Nipawin (Wheat).....	3.7	-1.6	-0.2
1950 Harvey, Hendon (Wheat).....	3.9	1.8	2.3
1950 Pederson, Fosston (Wheat).....	5.6	3.5	6.3
1950 Schlechte, Whittome (Wheat).....	7.1	0.1	5.2
1950 Pedersen, Star City (Barley).....	6.7	8.5	10.9

For stubble crops on soils low in organic matter or on soils in which a large amount of stubble from a previous crop is being worked in, a fairly liberal application of phosphate **plus nitrogen** is advisable, and 16-20-0 Ammonium Sulphate-Phosphate is recommended for these cases.

12.—ARE COARSE GRAINS AS RESPONSIVE TO FERTILIZER AS WHEAT?

Barley is apparently more responsive than wheat—a fact which is particularly important in weed control using early barley.

Oats respond very similarly to wheat.

Flax is erratic in its response, but is roughly similar to wheat. A possibility exists of affecting the germination of flax with more than 30-40 pounds per acre of 11-48-0.

13.—WHAT ARE THE BENEFITS FROM THE USE OF FERTILIZER?

Fertilizer gives many important advantages:

- (a) Increased yield averaging about 5 bushels increase for 25 lbs. 11-48-0 Ammonium Phosphate per acre, and about 7 bushels increase for 40 pounds 11-48-0 Ammonium Phosphate per acre on summerfallow crops.



Unfertilized

Fertilized
30-40 pounds 11-48-0

Coarse grains respond well to fertilizer. Barley appears to be the most responsive grain crop.

- (b) Earlier maturity and stronger straw, reducing the hazards of frost, insects, disease and weather. Earlier maturity and stronger straw are frequently very important on new breaking. About 30-40 pounds of 11-48-0 will usually have the desired effect.
- (c) Better weed control, since the crop is fertilized and grows faster than the weeds.
- (d) Uniformity in the crop—more even height and uniform ripening time, making harvesting much easier, and being reflected also in better grades.
- (e) Reduction in root-rot damage, especially Browning root-rot which is well controlled by phosphatic fertilizers.
- (f) Reduced soil erosion and higher rates of water intake in soils by virtue of higher production of straw and better trash cover.
- (g) Reduced soil deterioration through replacement of depleted soil fertility.
- (h) Better maintenance of organic matter through the return of more crop residues to the soil.

14.—CAN FERTILIZER IMPROVE THE NUTRITIVE VALUE OF CROPS?

Yes. Many experiments have shown that:

- (a) Frequently stock prefer fertilized crops due to their greater palatability.
- (b) One ton of a fertilized crop will often put more pounds of gain on animals than will be put on them by the same amount of unfertilized feed from the same field.

15.—HOW DOES FERTILIZATION HELP THE CROP SUPPRESS WEEDS?

When a proper fertilizer attachment on the grain drill or one-way is used, fertilizer is placed in the soil near the grain seed. As soon as the seed germinates, the young roots are able to use the nutrients in the fertilizer and this gives the crop the best possible start. Most weed seeds will be much farther from the fertilizer granules than the seeds of the crop. Therefore, weeds have to grow for some time before their roots reach the fertilizer granules and consequently the weeds do not get the same good start that the crop gets. The crop gets "the jump" on the weeds and is able to keep ahead of them throughout the season. Better crops with fewer weeds commonly result.



Not Fertilized

Near Birch Hills, Sask., 1950

Fertilized

The fertilized crop stools better and grows faster; it has a better chance to meet unfavorable weather conditions and is generally better able to withstand the attacks of insects or disease.



Not Fertilized

Near Cutknife, Sask., 1949

Fertilized

Note earlier maturity, larger heads and denser stand of fertilized grain. Note also weedy condition of unfertilized strip.

16.—IS IT TRUE THAT “ONCE YOU USE FERTILIZER, YOU MUST ALWAYS USE IT”?

If you use a fertilizer and get a profitable yield increase, that is a sign the soil needs fertilizer. Therefore, it is only good sense to continue to use it. The statement should read “once you get a profitable increase, you should continue to use fertilizer.” If there is consistently no yield increase, there is no point in continuing to try the fertilizer, and no harmful results occur if its use is discontinued.

17.—DO HARMFUL MATERIALS ACCUMULATE IN THE SOIL FROM LONG CONTINUED USE OF COMMERCIAL FERTILIZER?

No. The recommended fertilizers do not injure the soil. At Rothamsted, England, there are fields which have been cropped and fertilized continuously for a hundred years. There, correctly fertilized plots produce twice the crop of the unfertilized plots. Moreover, if fertilization of one of these plots is discontinued, that plot still outyields the plots that have never been fertilized. Similar results have been obtained from other long-time fertilizer experiments in the United States.

Commercial fertilizers which are recommended in Saskatchewan will not injure the soil or plants if used according to directions. Sometimes excessively heavy applications of fertilizer are used in gardens with injurious results to the plants. This is because roots of plants (especially tender young seedlings) may be injured by such excessively heavy applications of fertilizer. For the garden, an application of about one tablespoonful per ten feet of row is recommended. Field crops will not be injured by any recommended rate of the kinds of fertilizer advocated in Saskatchewan.

18.—IF A CROP IS FERTILIZED IN A DRY YEAR AND NO YIELD INCREASE IS OBTAINED, WILL THE FOLLOWING CROP BENEFIT FROM THE FERTILIZER?

There is little benefit the second year from phosphatic fertilizers on cereals in Saskatchewan. The phosphate of the fertilizer undergoes a slow chemical change in the soil so that subsequent crops get little benefit. However, the heavier the rate of application, the greater the probability of a response the second year.

In the Grey Soil Zone, where alfalfa responds to sulphur, marked benefits from fertilizer may be obtained in subsequent years, as is illustrated in the data below:

TABLE VI—Residual Effects of Fertilizer on Oats following Fertilized Alfalfa—Grey Soil Zone

Fertilizer Used 1944	Oat Yields 1945 after Alfalfa	
	Straw Yield tons/acre	Grain Yield bus./acre
16-20-0 (has sulphur)	1 78	47
11-48-0 (lacks sulphur)	0 63	25
No fertilizer	0 81	26

TABLE VII—Residual Effects of Fertilizer on Alfalfa. Grey Soil Zone

Fertilized 1945	Rate of Application lbs./acre	Yields 1947	
		Hay Yield tons/acre	Seed Yield lbs./acre
16-20-0 Ammonium Phosphate	100	1 80	234
Ammonium Sulphate	58	1 41	160
Gypsum	60	1 44	168
Check	Unfertilized	1 12	85

19.—SHOULD FARM MANURE BE USED AS A FERTILIZER?

Yes, if possible. Farm manure is an excellent fertilizer, particularly on gardens, sandy soils, eroded knolls and alkali flats, since it contains all the nutrients required by plants (although not in the correct proportions). Moreover, it adds organic matter (humus) to the soil. The average ton of farm manure contains 10 pounds of nitrogen, 5 pounds of phosphate, and 10 pounds of potash. The cost of this amount of plant nutrients is over two dollars if they are bought in the form of commercial fertilizer. However, the benefits obtained from manure are greater than those attributable to its content of nitrogen, phosphate and potash.

The greatest need of Saskatchewan soils is for phosphate, and since manure has a low content of this nutrient, it is advisable to apply some phosphatic fertilizer on manured fields.

Manure makes an excellent top dressing for pastures and forage crops. It should be spread as thinly as is convenient, preferably with a manure spreader. Usually there is not enough manure to cover all the land and it has been found that light applications on a large acreage give better results than heavy applications on a small acreage. Beneficial results are usually obtained for a number of years.

If manure contains weed seeds they may be destroyed by piling the manure and allowing it to heat. If there is no difficulty due to weed seeds and if it is convenient to do so, better results are usually obtained by hauling the fresh manure directly on to the land, unless it is excessively strawy. Except for garden use, rotted manure is little better than fresh manure and only about one ton of it is obtained from two tons of fresh manure.

Manure is especially beneficial in cases such as the following:

- Soils low in organic matter (humus).
- On light colored knolls where the limy subsoil is exposed.
- In the Grey Wooded Soil Zone and in the low spots of other zones where grey soil has resulted from tree growth.
- Low spots moderately affected by "alkali."
- Sandy soils.
- Gardens, pastures, and hay land.

Except in the very dry parts of the province, manure applied at light rates will increase yields of most crops. Even in the drier areas manure usually benefits hay land, pastures and gardens. Because manure has a high nitrogen content heavy applications may cause lodging of some crops.

20.—HOW AND WHEN IS FERTILIZER APPLIED?

For cereal crops fertilizer should be applied at the time of seeding, using a proper fertilizer attachment on the grain drill or one-way. Fertilizer should not be mixed with grain in the box as it may injure the machine and may result in uneven rates of seeding and fertilization.

Forage crops may be fertilized in two ways. The fertilizer may be applied by going over the field with a drill or one-way having a fertilizer attachment. If the ground is not too firm, it should be possible to get the fertilizer into the soil an inch or so and this may bring better results from the fertilization. Fertilizer may also be applied broadcast on forage crops by hand or by using a cyclone seeder or some similar type of implement. Forage crops should be fertilized in the fall.

21.—WHERE CAN I GET A FERTILIZER ATTACHMENT?

Fertilizer attachments can be obtained from your local fertilizer or implement dealer. Attachments to fit any size and make of drill and one-way are available. The cost of the attachment depends on the number of runs. For drills, attachments cost about \$3.00 per run while for one-ways they cost about \$4.00 per run. Properly cared for, attachments last many years. They are easily adjustable for different rates of fertilization. New drills can be purchased with a built-on attachment.

22.—HOW MUCH DOES FERTILIZER COST?

In Saskatchewan the cost of fertilizer is determined by two factors:

- (a) The analysis of the fertilizer. (This is explained on page 4).
- (b) The distance that the manufacturer has shipped the fertilizer.

TABLE VIII—Cost of Fertilizers in Saskatchewan

Name of Fertilizer	Analysis	Sulphur Content*	Approximate cost per ton (1951)
Ammonium Phosphate	11-48-0	2	\$96.45
Ammonium Phosphate	16-20-0	14	73 45
Ammonium Sulphate	21- 0-0	25	60 45
Ammonium Nitrate	33- 0-0	0	79 95
Complete	9-27-9	5	87 45

*Sulphur content is not shown in guarantee of analysis of fertilizers. It is an important fertilizer element for legumes on Grey Wooded Soils.

23.—HOW CAN I CONDUCT MY OWN FERTILIZER TRIAL?

The only way to be absolutely sure whether fertilizer is needed on a particular piece of land is to try fertilizer there. Any farmer can conduct his own fertilizer trial.

Sow fertilizer in strips down the field, leaving an unfertilized strip for comparison. Make the strips wide enough so that each strip will be at least as wide as a full swath of the combine. At harvest time an accurate comparison of yield may be made by catching the grain from a full swath of each strip and weighing it. Observations during the growing season of height and earliness alone cannot be depended upon to tell whether a yield increase is obtained.

Do not base your conclusions on one year's results. Results will differ with the seasons. Fertilizer should be tried for several years before definite conclusions are reached. It is a good idea to leave an unfertilized strip in each field every year.

24.—HOW CAN THE BURNED-OVER PEAT SOILS BE IMPROVED?

Burned-over peat land may produce two or three good crops, but yields usually decline very rapidly.

This is because these soils are generally low in fertility. They may be improved by use of fertilizer and by addition of organic matter. The incorporation of farm manure, straw, stubble, and green manures will help these soils. Growing inoculated legumes should be especially beneficial. Where no organic matter is being added, use 16-20-0 at 50 to 75 pounds per acre, while with a rotation using manure or a legume apply 11-48-0 at 40 to 60 pounds per acre.

25.—WHAT FERTILIZER IS BEST FOR PEAT?

Information about fertilizing peats in Saskatchewan is rather scant, so that only general recommendations can be made. The following treatments are suggested:

- (a) Farm manure at 10 tons per acre
- (b) 11-48-0 at 50 pounds per acre
- (c) 16-20-0 at 75 pounds per acre.

Manure, plus 11-48-0, may produce good results as well.
Proper drainage of peat land is important.
Peat should always be well packed at seeding.
Hay and coarse grains are the most suitable crops.

26.—DOES FERTILIZER IMPROVE “ALKALI” SOIL?

Very marked benefits are often obtained from the use of fertilizer on soils of moderate “alkali” content. The use of 11-48-0 at not less than 40 pounds per acre will do a great deal to overcome the unevenness of fields with small depressions in which there has been an accumulation of “alkali” salts. Fertilizer will not overcome the problems associated with soils high in “alkali.”

Further information on “alkali” soils can be found in “The Guide to Farm Practice in Saskatchewan,” obtainable from any Agricultural Representative.

27.—IS LIME NEEDED IN SASKATCHEWAN?

No. With few exceptions, Saskatchewan soils have a bountiful supply of lime. In fact, some Saskatchewan soils have free lime present in their surface layer; this represents an undesirable excess of lime which is detrimental to some plants. Fruit trees, blueberries and other plants which prefer acid conditions do poorly when free lime is present in a soil. However, there is no practical treatment to help such soils other than to incorporate all available organic matter. **If it is thought that a field may require liming, send a sample of the soil, taken according to directions given in this bulletin, to the Soils Department, University of Saskatchewan. A simple test will determine definitely whether or not lime should be applied.**

28.—WHAT EFFECTS DO THE DIFFERENT FERTILIZER NUTRIENTS HAVE ON CROPS?

(a) Nitrogen:

- 1.—If needed, nitrogen will increase yield.
- 2.—It produces a rank succulent vegetative growth of a healthy dark green color.
- 3.—It helps prevent shrivelled light weight seeds.
- 4.—It may help plants get an earlier start in spring.
- 5.—Too much nitrogen will cause lodging. (For example, a crop grown where there has been a manure pile usually lodges due to the excessive amounts of nitrogen which causes too much growth.)
- 6.—Too much nitrogen will delay ripening of crops and make them more susceptible to some diseases.

Where there is adequate moisture, nitrogen usually produces an increase of growth with crops such as lettuce, cabbage, rhubarb, greenfeed, hay, lawn grass, etc. Nitrogen is the most expensive nutrient to buy. It may be put into the soil by growing inoculated legumes such as alfalfa, sweet clover, red clover, and by applications of manure or nitrogenous commercial fertilizers.

(b) Phosphorus or phosphate:

- 1.—If needed, phosphorus will increase yields.
- 2.—It helps produce big, strong healthy root systems. Browning root-rot can be largely controlled by use of phosphatic fertilizer. It is important for root crops such as beets, turnips, etc.
- 3.—It helps produce bigger, plumper, fuller heads and kernels.
- 4.—Phosphorus helps crops ripen earlier. In many cases it may increase maturity of a grain crop by a week or more.
- 5.—It helps strengthen straw and so may help prevent lodging.
- 6.—In general, there is no danger of getting too much phosphate on field crops but in gardens **excessively heavy** rates may be injurious.
- 7.—Phosphate may improve the quality of crops.
- 8.—It helps crops suppress weeds.

When crops have adequate moisture phosphate will increase yields and enable the crop to make better use of the moisture present in the soil. It is the nutrient most often needed in Saskatchewan.

(c) Potassium or potash:

As yet, there is little indication that this element is required as a fertilizer in Saskatchewan, although it may be needed on some sandy soils. It is quite probable that some

peat land ("moss," "muskeg," or "swamp" land) in this province will need potash either when it is first cropped or within a few years.

- 1.—If needed, potassium will increase yields.
- 2.—Potash is a balancer for other nutrients and makes healthier plants so enabling them to resist disease better.
- 3.—It may help to strengthen straw.

(d) Sulphur.

- 1.—Some of the soils in the grey soil zone, especially the sandy and medium textured ones, may need this nutrient as a fertilizer for legumes. Cereal crops are not likely to need this element as a fertilizer, although its indirect effects may be important to them. (See Table IV.)
- 2.—If needed, sulphur will increase yields. Yield of alfalfa hay is frequently increased by more than 100% and yield of alfalfa seed has been more than doubled.
- 3.—Sulphur improves the root system, making stronger healthier roots.
- 4.—It causes more vegetative growth.
- 5.—Sulphur helps increase the number of flowers on each alfalfa plant.
- 6.—Sulphur helps increase the protein content of alfalfa hay thus making it a better feed.
- 7.—If a heavy application of sulphur carrying fertilizer is put on land, beneficial results will be obtained for more than one year. (See page 11.)

29.—CAN THE NEED FOR FERTILIZER BE DETERMINED BY LOOKING AT THE CROP?

It is seldom that the lack of a nutrient is so serious that the crop shows the effects of the deficiency. In Saskatchewan most crops on land which will give profitable yield increases from use of fertilizer look quite healthy and normal. The only sure way to determine fertilizer needs is by a fertilizer trial—which any farmer can conduct for himself.

When there is a very serious lack of a nutrient, crops may show symptoms of the deficiency. These deficiency symptoms for the elements most likely to be concerned in Saskatchewan are listed below:

- (a) Symptoms of phosphate deficiency:
 - 1.—Slow growth and lack of stooling.
 - 2.—Sometimes there may be a purplish tinge to plants.
 - 3.—May cause a pale greyish-green color.
 - 4.—In wheat the tips of older leaves die back.
 - 5.—Cereals mature early but produce grain slowly.
 - 6.—Livestock show unnatural appetites—eat and lick at bones, etc.
- (b) Symptoms of nitrogen deficiency:
 - 1.—Yellow-green color over the whole leaf.
 - 2.—Poor stunted growth.
 - 3.—Early maturity and poor seed yield.
- (c) Symptoms of sulphur deficiencies:
 - 1.—Alfalfa has pale green appearance.
 - 2.—Reduces crop growth.

30.—HOW CAN YIELDS BEST BE MAINTAINED OR INCREASED?

Experiments in Europe and North America show clearly that two things are necessary to maintain or increase yields over a long period of time:

- (a) Rotation of crops in which legumes or grasses are included.
- (b) Fertilization.

It is realized that a system of cropping including legumes or grasses is difficult to adapt to parts of Saskatchewan. However, such a system can and should be adopted in much of this province—especially in the grey and transition soil zones, and on sandy soils generally.

31.—WHY ARE CROP ROTATIONS RECOMMENDED?

Experience the world over has shown that **in the long run yields can be maintained only when crops are rotated and fertilized**. There is no reason to believe that this principle, which applies to the rest of the world, does not apply in Saskatchewan.

Forage crops have root systems that are quite different from those of cereals. The roots of grasses and legumes are tougher and more resistant to decomposition than are

the roots of the grain crops. Moreover, forage crops do not require the same amounts and proportions of plant nutrients as are required by cereals. Different plants obtain their nutrients from different depths and layers in the soil.

Crop rotation results in a balanced use of the plant nutrients in the soil. Moreover, rotation of crops greatly reduces erosion and helps maintain the humus content of the soil. The control of weeds, plant diseases and insects is facilitated by crop rotation.

32.—ARE THERE ANY SOILS IN SASKATCHEWAN WHERE CROP ROTATION IS ESPECIALLY IMPORTANT AND DESIRABLE?

Yes. Crop rotation is essential on all types of grey-wooded soils and on sandy soils suited to cultivation throughout the province. Many soils in addition to these would benefit from the adoption of a suitable rotation.

The humus content of sandy soils decreases very rapidly when they are cultivated. As a result they become particularly susceptible to erosion and their yields decrease markedly. In Saskatchewan many successful farmers on sandy land now use a rotation system whereby the land is cultivated for a few years and is then seeded down to grasses or legumes for at least an equal number of years. Such a rotation helps maintain the organic matter content of these sandy soils and is very effective in reducing erosion on them.

Grey-wooded soils are very low in organic matter and a rotation including a legume is essential to good crop production. The combination of a rotation and phosphate-sulphate fertilizers is essential for high production and good yields.

For suitable rotations consult your Agricultural Representative, your nearest Dominion Experimental Farm, or the College of Agriculture at the University, Saskatoon.

33.—WHAT FERTILIZER SHOULD I USE ON MY PASTURE AND HAY CROPS?

There is very little information available as to the fertilizer needs of grass crops. Experimental evidence indicates that where grass productivity is reasonably high, that is in the Black, and Degraded Black and Grey-Wooded Soil Zones, fertilizing pasture and hay fields may be quite profitable. In 1950, one unproductive pasture at Kinistino* which yielded less than $\frac{1}{4}$ ton per acre (green weight), gave a yield of almost 2 tons per acre (green weight) with a dressing of 120 pounds of ammonium nitrate per acre, under relatively unfavorable conditions. Under good conditions, larger increases should be easily obtained.

Anyone wishing to test fertilizers on grass in hay or pasture fields, should use ammonium sulphate, 21-0-0, at about 200 pounds, or ammonium nitrate, 33-0-0, at about 120 pounds per acre, either application being equivalent to 40 pounds of nitrogen per acre.

For established stands of forage crops the fertilizer may be applied by using an empty grain drill with a fertilizer attachment, or the fertilizer may be broadcast with a cyclone seeder. Aside from yield determinations, careful observations should be made to see whether livestock show preference for the fertilized product.

Manure is a very good fertilizer for pasture and hay crops. It is particularly good for sod-bound brome grass and similar crops. The manure should be spread as lightly as is convenient. Beneficial results should follow for some years.

Additional enquiries about fertilizing forage crops should be addressed to the Dominion Forage Crops Laboratory, University of Saskatchewan, Saskatoon, or to your nearest Dominion Experimental Station.

34.—WHAT FERTILIZER IS NEEDED FOR ALFALFA WHICH IS BEING GROWN FOR SEED?

In the Grey Soil Zone where most of Saskatchewan's alfalfa seed is grown, the use of sulphur carrying fertilizers often gives tremendous yield increases. This is especially true with light textured (sandy) soils although highly satisfactory yield increases from sulphur fertilization of alfalfa have also been obtained on some medium (loam) and heavy textured (clay) soils. The data below show results obtained on sandy soils:

*Test conducted by Melfort Experimental Station.



Effect of sulphur carrying fertilizer on growth of legume (clover) on grey wooded soil. Man on right is standing in fertilized strip. 16-20-0 is a suitable fertilizer for legumes on such soils.

TABLE IX—Average of Data Obtained from Two Alfalfa Fields in Whitefox District
Dominion Forage Crops Laboratory, 1945.

Fertilizer used	Rate in lbs./acre	Amt. of Sulphur applied	Hay Yield Tons/acre	Seed Yield lbs./acre
No fertilizer.....			0.80	32
Ammonium Phosphate 16-20-0	50	7	2.11	80
	100	14	2.32	90
Ammonium Sulphate 21-0-0.....	29	7	2.18	96
	58	14	2.23	99
Gypsum (Calcium Sulphate)....	60	14	2.22	80

The efficiency of sulphur, whether alone or in combination with other materials, in increasing seed yields is obvious in the above data. 1945 was not a particularly good year for alfalfa seed production, but even so the sulphur fertilizers increased seed yields about three times.

16-20-0 ammonium phosphate is the recommended fertilizer for alfalfa seed production because it contains both the sulphur and phosphate which the Grey-Wooded soils are deficient in. With sulphur alone, yields will soon be limited by a shortage of phosphate.

Gypsum is a cheap source of sulphur, and can be used to correct the sulphur deficiency, providing some attention is paid to the phosphate status of the soil. One possibility is to fertilize the legume heavily at the time of seeding with a nurse crop, using 16-20-0, and broadcasting gypsum instead of 16-20-0 annually thereafter to maintain the sulphur supply.

35.—HOW CAN A SOIL TEST BE USEFUL?

Soil tests may be helpful where some particular soil problem exists. The following cases are examples where useful knowledge may be obtained from a soil test:

- (a) Presence of alkali is suspected.
- (b) The soil is thought to be acid (sour).

- (c) Presence of an unproductive area in a field that is otherwise productive.
- (d) A field is of distinctly low productivity.
- (e) Peculiarities of plant growth on an area.
- (f) It is thought lime may be needed.

36.—IS A SOIL TEST NECESSARY TO TELL WHAT FERTILIZER IS NEEDED?

Since practically all Saskatchewan soils test "low" to "very low" in available phosphate, a soil test usually merely confirms the statement that most Saskatchewan soils are deficient in phosphate. The Soils Department tests without charge soil samples sent in for examination. The best test is a trial strip in the field for a few years.

37.—HOW SHOULD SOIL SAMPLES BE TAKEN?

Great care must be exercised in obtaining a satisfactory soil sample so that it is representative of the area in question. Distinctly different types of soil should be sampled separately, never bulked in the same sample.

The Surface Sample.—A spade or trowel is a suitable implement to use in obtaining the samples. Select a uniform area and sample in 6 to 10 places, obtaining a uniform slice of soil to a depth of 6 inches each time. Place the individual samples in a clean pail or other container, mix thoroughly, and forward about 1 pound of the soil from this mixture.

The Subsoil Sample.—In order that the best information may be obtained, a sample of the subsoil should also be forwarded. Select a representative point in the area and obtain a sample of about 1 pound weight at a depth of 12 to 18 inches. The presence of gravelly layers or any unusual condition of the lower sub-soil should be mentioned.

Labelling.—Samples should be clearly labelled with the name and address of the sender. Also state whether the sample is from the surface or subsoil. It is preferable that samples be labelled on the outside of the container. If more than one sample is forwarded, they should be labelled in such a way that each set may be referred to separately.

Containers.—Samples must be forwarded in clean containers. Clean tins, paper bags, or cardboard boxes, are suitable. Never use containers which have held table salt, Epsom salts, baking soda, washing soda, etc.

The following information should be provided:

Location..... $\frac{1}{4}$ of Sec.....Tp.....Rge.....W. of.....
 How long has the land been under cultivation?.....
 What crops have been grown?.....
 Have you noted any peculiarities in the growth of crops?.....
 What weeds are most troublesome on the land?.....
 If the land is uncultivated, describe the natural vegetation in a general way.....
 Describe the topography (level, undulating, rolling).....
 Is the area low or subject to flooding?.....
 General remarks including reasons for requesting analysis.....

Soil samples to be tested should be sent to the Soils Department, University of Saskatchewan, Saskatoon. There is no charge for this service.

38.—WHAT ARE THE FERTILIZER RECOMMENDATIONS FOR MY AREA?

(a)—THE BROWN SOILS*

While there is not sufficient experimental evidence on which to base a general recommendation, preliminary trials indicate that 11-48-0 ammonium phosphate may give very worthwhile increases in some years. Suggested rates for private tests on individual farms are not less than 40 pounds per acre on the heavy soils, and not less than 30 pounds per acre on the medium textured loams and clay loams. Its use is probably justified only on summerfallow crops with reasonably good sub-soil moisture reserves. The lighter soils in this zone probably will not give profitable yield increases with phosphate due to their generally low productivity.

*See sketch map (inside front cover) for outline of soil zones, or consult Soil Survey Reports Nos. 12 and 13 obtainable from the University of Saskatchewan, Saskatoon.

(b)—THE DARK BROWN SOILS

Summerfallow Crops

Heavy soils (Regina Heavy Clay, Elstow Clay) — 40 to 60 pounds of 11-48-0 ammonium phosphate per acre.

Medium and Light Textured soils (Weyburn Loam, Cypress Loam, Asquith Light Loam and Fine Sandy Loam, etc.)—40 pounds of 11-48-0 per acre.

Stubble Crops

Fertilizer not recommended.

(c)—THE BLACK SOILS

Summerfallow Crops

Heavy soils (Indian Head Clay, Blaine Lake Clay)—40 to 60 pounds of 11-48-0 ammonium phosphate per acre.

Medium and Light Textured soils (such as, Oxbow, Ryerson and Waseca Loams, Meota Fine Sandy Loam)—40 pounds of 11-48-0 per acre.

Stubble Crops

11-48-0 at 40 pounds per acre, or for lighter soils and conditions where much trash is present, 16-20-0 ammonium phosphate at 50-75 pounds per acre is suggested for private tests on individual farms.

(d)—THE THICK BLACK AND SLIGHTLY DEGRADED BLACK SOILS

(Melfort and Tisdale Silty Clay Loams, Canora, Kamsack and Weirale Clay Loams and Loams, Yorkton, Naicam and Pelly Loam and Clay Loams, Meadow Lake and Beaver River Clay Loam, Shellbrook Light Loam, etc.).

Summerfallow Crops

40 to 60 pounds of 11-48-0 per acre, with the higher rate on heavier soils and where moisture reserves are good.



Near Cutknife, Sask., 1949

Left: Wheat from one square yard in unfertilized strip. Right: Wheat with 11-48-0 at 40 pounds per acre from one square yard of fertilized strip.

Stubble Crops

11-48-0 at forty pounds per acre or 16-20-0 at fifty to seventy-five pounds per acre. 16-20-0 is preferable where a large amount of trash is being worked in. Stubble responses in these soils will be fairly reliable in general.

(e)—THE GREY-WOODED AND STRONGLY DEGRADED SOILS

(Whitewood, Loon River and Waitville Loam, Arborfield Clay, Carrot River, Whitefox and Sylvania Sandy Loams, etc.)

Good yields and high productivity can only be obtained in these soils by the use of a good rotation involving a legume, either turned in as a green manure crop or used as forage and the manure returned to the land.

The use of fertilizers is much more profitable and gives greater yield increases when used in combination with a suitable rotation.

Since increasing the organic matter and nitrogen content of the soil is the object of using the legume, the success of the rotation depends on the success of the legume crop. It should be fertilized heavily at the time of seeding down with the nurse crop using up to seventy-five pounds of 16-20-0 per acre, to supply nitrogen and phosphate to the nurse crop and phosphorus and sulphur for the first year or two of growth of the legume.

Summerfallow Grain Crops should be fertilized with about sixty to seventy-five pounds of 16-20-0 if the organic matter supply is low, or about forty pounds of 11-48-0 if a suitable rotation is used.

Stubble Crops should be fertilized with fifty to seventy-five pounds of 16-20-0 per acre.

Legumes for Seed Production should be fertilized yearly with a sulphur-bearing fertilizer. 16-20-0 has given the best results, and its use is recommended at about fifty pounds per acre, applied in the fall.

39.—WHERE CAN I OBTAIN ADDITIONAL INFORMATION CONCERNING SOILS AND THEIR MANAGEMENT?

There are a number of publications containing information about the soils of Saskatchewan, their use and management.

- a. Soil Survey Reports Numbers 12 and 13, which cover the settled part of the province, are obtainable from the Extension Department, University of Saskatchewan.
- b. The Guide to Farm Practice in Saskatchewan, also obtainable from the Extension Department, University of Saskatchewan, contains a section with general information on Soils.
- c. The Experimental Farms have available a bulletin from the Soils Research Laboratory, Swift Current, entitled, "Report of Investigations."

Additional information concerning soils and soil problems may be obtained by writing to the Soils Department, University of Saskatchewan, or to the Soils Research Laboratory, Experimental Station, Swift Current, Saskatchewan.

**SASKATCHEWAN ADVISORY FERTILIZER COUNCIL
RECOMMENDATIONS
1951**

Soil Zone	Summerfallow Grain	Stubble Crop	Other Crops	
Brown				
Heavy soils	try 11-48-0 at 40 lbs./acre	none		
Med. textured soils	try 11-48-0 at 30 lbs./acre	none		
Dark Brown				
Heavy soils	40-60 lbs. 11-48-0	none		
Other soils	40 lbs. 11-48-0	none		
Black			Grasses	
Heavy soils	40-60 lbs. 11-48-0	try 11-48-0 at 40 lbs. or 16-20-0 at 50-75 lbs.	try	
Other soils	40 lbs. 11-48-0		am. sulph. 21-0-0 at	
Thick Black and Slightly Degraded Black	40-60 lbs. 11-48-0	40 lbs. 11-48-0 or 50-75 lbs. 16-20-0	200 lbs./acre or	
Grey Wooded and Strongly Degraded	40-60 lbs. 11-48-0	50-75 lbs. 16-20-0	am. nitrate at 125 lbs./acre	Alfalfa 50 lbs. 16-20-0 per acre per year

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